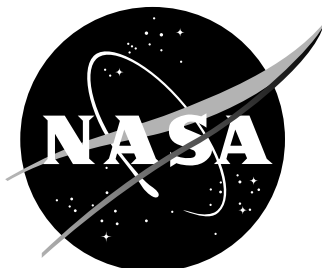


Lyndon B. Johnson Space Center  
Houston, Texas 77058

# **Technical Support Package**

## Urine-Sample-Collection Device for Use on the Space Shuttle

NASA Tech Briefs  
MSC-22748



National Aeronautics and  
Space Administration

Technical Support Package  
for  
**URINE-SAMPLE-COLLECTION DEVICE FOR USE ON  
THE SPACE SHUTTLE  
MSC-22748**

*NASA Tech Briefs*

The information in this Technical Support Package comprises the documentation referenced in **MSC-22748** of *NASA Tech Briefs*. It is provided under the Commercial Technology Program of the National Aeronautics and Space Administration to make available the results of aerospace-related developments considered to have wider technological, scientific, or commercial applications. Further assistance is available from sources listed in *NASA Tech Briefs* on the page entitled "NASA Commercial Technology Team."

Additional information regarding research and technology in this general area may be found in a variety of publications available from the NASA Scientific and Technical Information (STI) Program Office. You can access the STI Program Office via <http://www.sti.nasa.gov> or as follows:

NASA STI Help Desk  
NASA Center for AeroSpace Information  
7121 Standard Drive  
Hanover, MD 21076-1320

Telephone: (301) 621-0390, Fax: (301) 621-0134, E-mail: [help@sti.nasa.gov](mailto:help@sti.nasa.gov)

---

NOTICE: This document was prepared under the sponsorship of the National Aeronautics and Space Administration. Neither the United States Government nor any person acting on behalf of the United States Government assumes any liability resulting from the use of the information contained in this document or warrants that such use will be free from privately owned rights. If trade names or manufacturers' names are used in this report, it is for identification only. This usage does not constitute an official endorsement, either expressed or implied, by the National Aeronautics and Space Administration.

## **Urine-Sample-Collection Device for Use on the Space Shuttle**

Many scientific investigations performed during spaceflight require the collection of urine samples. Experiments using stable isotopes rely on determination of the ratio of the labeled to unlabeled isotope and seldom require quantitated urine output. A urine monitoring system (UMS) has been developed for the shuttle, but it is an extremely large instrument and is infrequently manifested. The urine collection devices (UCD) currently used on the shuttle middeck are cumbersome to use and have a high incidence of leaking. There are no inflight UCDs available for women. Volume and weight constraints onboard spacecraft severely limit the availability of storage space for empty and filled UCDs during flight. Identifying a means of collecting small random urine samples from both men and women would lessen the impact of these limitations.

A prototype inflight urine collection absorber (IUGA) was developed to collect small random samples during flight. This conical shaped unit was constructed to have an area of approximately 75 sq. cm from a material which is known to absorb 20.4 grams of water per 100 sq. cm. The IUGA assembly weighs approximately 20 grams empty and 35 grams full as compared to the UCD assembly which weighs 65 grams empty and typically weighs 300 to 400 grams when full. The IUGA was designed to be placed in either male or female urine collection funnels attached to the shuttle waste collection system (WCS). Theoretically, as the crew member voids, the vortex action created by the shuttle vacuum system would allow urine to saturate the IUGA. Upon completion of the void, the IUGA would be removed from the system, placed in two Ziploc® bags, or equivalent, and stored in an absorber containment bag for return. The prototype was tested several times for volume recovery using the WCS mock-up (NASA/JSC Building 5); however, due to gravitational effects, results were inconclusive. Flight safety testing was completed and the prototype units were certified for flight use.

The developed technology allows routine collection of random urine samples by both male and female crew members. This technology is only applicable for experiments where urine volume measurements are not required. Preliminary evaluation studies were performed to evaluate the effect of the absorbent paper on the analysis of deuterium and oxygen-18, two isotopes currently in use for the determination of energy expenditure, water metabolism, and body composition.

## 1. *STUDY 1 (Ground-based)*

Labeled water (JSC tap water enriched with deuterium and oxygen-18) was prepared and aliquots of the stock were placed into UCDs and unassembled IUCAs. The UCDs and IUCAs were stored at room temperature and sampled at 1-, 2-, and 3-week intervals. Samples were periodically weighed to monitor gross evaporative losses. The results of this study are described below:

Evaporative losses were minimal for the IUCA samples, and far less than that of samples stored in the UCD (Figure 1). Moreover, stable isotope enrichment of the IUCA samples compared well with the UCD samples (Figures 2 and 3).

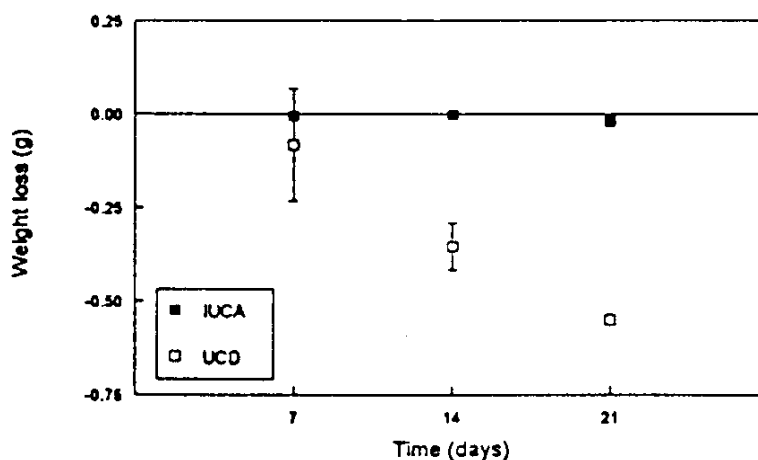


Figure 1  
Evaporative Losses – IUCA vs. UCD Storage

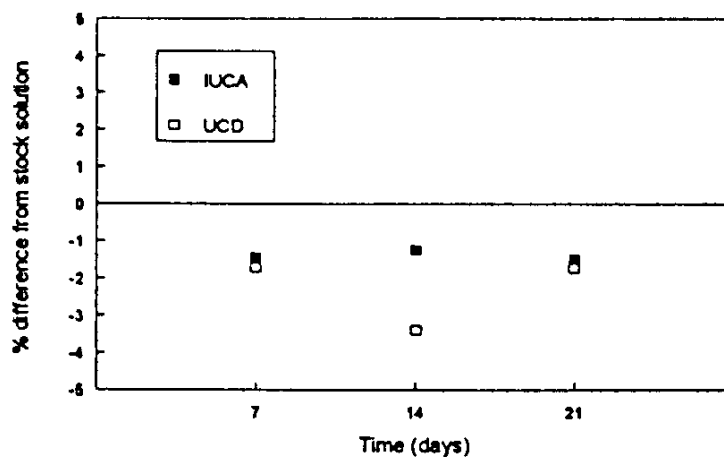
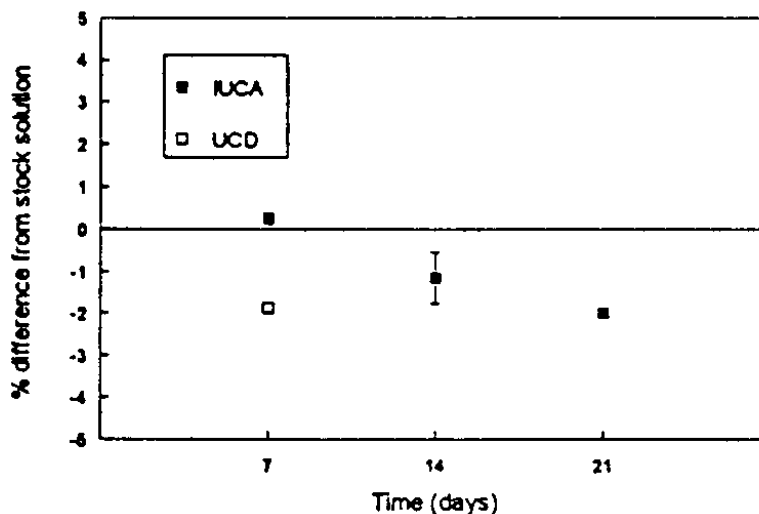


Figure 2  
Oxygen-18 Enrichment – IUCA vs. UCD (Unprocessed Samples)



**Figure 3**  
**Deuterium Enrichment**  
**IUCA vs. UCD (Processed Samples)**

## 2. *STUDY 2 (Ground-Based)*

Total energy expenditure (TEE) and total body water were determined from analyses of oxygen-18 and deuterium in urine after the ingestion of the isotopes. Urine samples were collected using the standard ground-based procedures and aliquots were stored using the IUCA and the UCD. The results of this study are described in Table 1.

**Table 1**

MEASUREMENT	STANDARD (Ground)	UCD (Standard - Flight )	IUCA
TEE (kcal/day)	3279 $\pm$ 105	3147	3533
Total Body Water (kg)	45.24 $\pm$ 1.12	44.44 $\pm$ 0.62	45.82 $\pm$ 1.08

TEE and total body water measurements derived from samples stored in either the UCD or IUCA compared favorably with the standard methods.

## 3. *STUDY 3 (Flight)*

A DTO was manifested on STS-67 and STS-70 to verify inflight performance of the IUCA using both male and female crew members. Volumes of at least 5 ml are typically required for various

analytical procedures. Random urine samples were collected from 5 crew members (3 males, 2 females) on 2 to 4 days during flight. The total amount of urine recovered from each IUCA was measured postflight (Table 2). Results indicate that sufficient urine can be recovered from the IUCA to perform stable isotope analyses.

**Table 2**

<i>SUBJECT (gender)</i>	<i>MISSION</i>	<i># OF SAMPLES</i>	<i>VOLUME (ml)</i>
1 (male)	STS-67	4	13.3 $\pm$ 1.1
2 (female)	STS-67	4	12.4 $\pm$ 0.1
3 (male)	STS-70	3	11.0 $\pm$ 2.2
4 (male)	STS-70	3	12.3 $\pm$ 0.4
5 (female)	STS-70	2	12.4 $\pm$ 0.4

The introduction of the IUCA is a major breakthrough for inflight urine collections, offering an alternative for urine collections where volume measurements are not required. Preliminary data confirm the utility of the IUCAs in protocols using oxygen-18 and deuterium. The lightweight design, small size, and ease of use will allow routine shuttle collection of random urine samples by both male and female crew members and should be adaptable for use on *Mir* and future space station flights. Previously, UCDs were used for collection of most urine samples on shuttle and were restricted to male crew members. Collection of sample from females required the use of the UMS, which is infrequently manifested due to its large size. Furthermore, the IUCA is compatible with dry urine storage technology being developed at this time.